AIR QUALITY MONITORING AND ASSESSMENT IN THE VILLAGE OF L'ORIGINAL 1977 TO 1987

SEPTEMBER 1989

Environment
Ontario

Jim Bradley
Minister

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AIR QUALITY MONITORING AND ASSESSMENT
IN THE VILLAGE OF L'ORIGNAL
1977 TO 1987

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SEPTEMBER 1989

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SUMMARY

This survey work was conducted in response to citizen complaints about the operations of Ivaco Rolling Mills. Sampling was conducted during the period of May 1977 to December 1987. Sampling locations were selected to evaluate the company's impact on the local air quality. The six sites generated 3000 test results for air contaminants. The results were compared to levels set out in Ontario Regulation 296. The survey work investigated TSP, iron oxide, and heavy metals such as lead and cadmium. Total suspended particulate (TSP) and metals composition in samples collected in the L'Orignal area met the 24-hour ambient air quality criteria (AAQC).

Plant pathology studies conducted by the Air Resources Branch (ARB) indicate that Ivaco was a minor source of heavy metals deposition. Surveys were conducted yearly and identified Ivaco as a minor source of iron and chromium (appendix 3).

INTRODUCTION

The village of L'Orignal is located on the Ottawa River between the cities of Ottawa and Hawkesbury. There has been a long history of air pollution complaints in L'Orignal. These complaints prompted investigations of the local air quality and its possible effects on vegetation and forage.

The major industrial source in this vicinity is Ivaco Rolling Mills, an electric arc steel mill. Ivaco processes scrap metal from automobiles to produce fence wire, nails, steel bars, and specialty castings. The use of automobiles as a feed stock suggested possible emissions of: iron oxide, lead, chromium, and zinc.

The land use in the L'Orignal area is residential and farming in addition to the steel mill. Consequently, the Phytotoxicology section of ARB became involved in assessment of the local vegetation. ARB scientists examined possible pathways that contaminants could enter the food chain in the area. Regional staff collected samples to examine the particulate concentrations and composition of the air.

MONITORING PROGRAM

Sample collection was conducted at 6 separate sites, which are depicted on Map 1 (appendix 1.1). Each survey was evaluated when sample results were available and the program evolved as new equipment and test procedures were developed.

Particulate in the air was collected on filters and analyzed with atomic absorption and later with x-ray fluorescence.

CHRONOLOGY

June 1977	Hivol stations 56076 & 56077 were established to monitor 24-hour total suspended particulate (TSP) and its metals composition.
Dec. 1977	Station 56076 was terminated.
May 1978	Station 56077 was terminated.
July 1979	Public complaints were received, and Hivol station 56076 was restarted to collect particulate samples.
Sept. 1979	Station 56076 was terminated. Dust samples from the fume collection system of the steel mill were examined.
Sept. 1984	Public complaints were received, and station 56095 was initiated. A new collector was deployed (Metrex sequential). Daily samples were collected to examine metallic content. The compounds of interest were determined based on previous results. Total suspended particulate was estimated by summing the weights of the target compounds and compared to Hivol samples collected at the same place and time.
Nov. 1984	Station 56095 was terminated.
July 1987	Public complaints continued, and station 56095 was re-activated. Monitoring was also conducted on the property of 2 local citizens. Sequential samplers were used. Metals composition was investigated.
Sept. 1987	Monitoring was discontinued.
Dec. 1987	Sequential samplers were deployed on private property to measure metallic composition.

SAMPLE RESULTS

The ambient air quality criteria (AAQC) are presented on page 6.

Many of the contaminants reported by the laboratory were measured to be zero and are not included in this report.

The soiling properties of the particulate stem from the presence of iron oxide (common rust). Iron oxide values were computed from elemental iron values determined in the laboratory (appendix 1.2).

1977-1978

Station 56076

AAQC for TSP and metals were met. Twenty-one samples showed a maximum TSP value of 56 micrograms per cubic meter. Values less than 120 are acceptable. The results are tabulated in appendix 1, and TSP data are charted in appendix 2.

Based on these findings, this station was terminated.

Station 56077

AAQC for TSP and metals were met. Fifty-three samples showed a maximum TSP value of 64 micrograms per cubic meter. The maximum lead concentration of 49 samples was one-third of its AAQC. Appendix 1.3 contains tables of TSP and metals data. Appendix 2.2 is a chart of the TSP findings.

Based on these results, monitoring was discontinued and the sampling equipment was removed.

July 1979 - September 1979

Station 56076

Total suspended particulate in 14 samples met the AAQC. Metals were not found in significant amounts. Appendix 1.3 presents the tabulated results of this survey. Based on these results, monitoring was discontinued.

Material from the fume collection system showed the presence of seven environmentally significant metals: Iron (as iron oxide), zinc, lead, manganese, copper, chromium, and cadmium. These metals formed the target list of compounds for future study.

BAGHOUSE DUST EXAMINATION

Percentage composition by weight

Iron	24.0
Zinc	15.0
Lead	8.1
Manganese	2.6
Copper	0.2
Chromium	0.15
Cadmium	0.06

OTHER ELEMENTS - 49.89

Sept. 1984 - Nov. 1984

Station 56095

The results were below relevant criteria. Forty-one samples were collected. Comparison of Hivol TSP to Sequential TSP was done. The agreement was acceptable, and presented graphically in appendix 2.6 and tabulated in appendix 1.4 . TSP values were below AAQC throughout the entire monitoring program, and focus was shifted to the composition of collected material. Soiling and toxicity were the main concerns expressed by complainants, and these effects form the rationale for the metallic composition criteria.

The highest iron oxide value was 20 micrograms per cubic meter, compared to its' criterion of 25. Lead, chromium, and zinc were found at levels below their respective criteria.

Based on these results, monitoring was discontinued.

July 1987

The eleven samples met 24 hour AAQC for metallic composition. The major target component was iron oxide. Trace amounts of zinc, lead, and chromium were found. These data are tabulated in appendix 1.6.

Dec. 1987

The 23 samples met the 24 hour AAQC for metallic composition. The major components were: iron oxide, and zinc. Trace amounts of manganese, lead, and chromium were found. These data are tabulated in appendices 1.7 and 1.8.

CONCLUSIONS AND RECOMMENDATIONS

The air quality in the L'Orignal area has been consistently within ambient air quality criteria. Compounds in material likely to be emitted by Ivaco have been found in air samples, but at levels below those set out in Ontario Regulation 296.

Plant pathology studies have demonstrated occasional exceedances of tentative guidelines set out by ARB. Ivaco was identified as a minor source of metals deposition.

No further air monitoring in this area is recommended since ten years of concentrated study has failed to find any exceedences of Ontario's Air Quality Criteria.

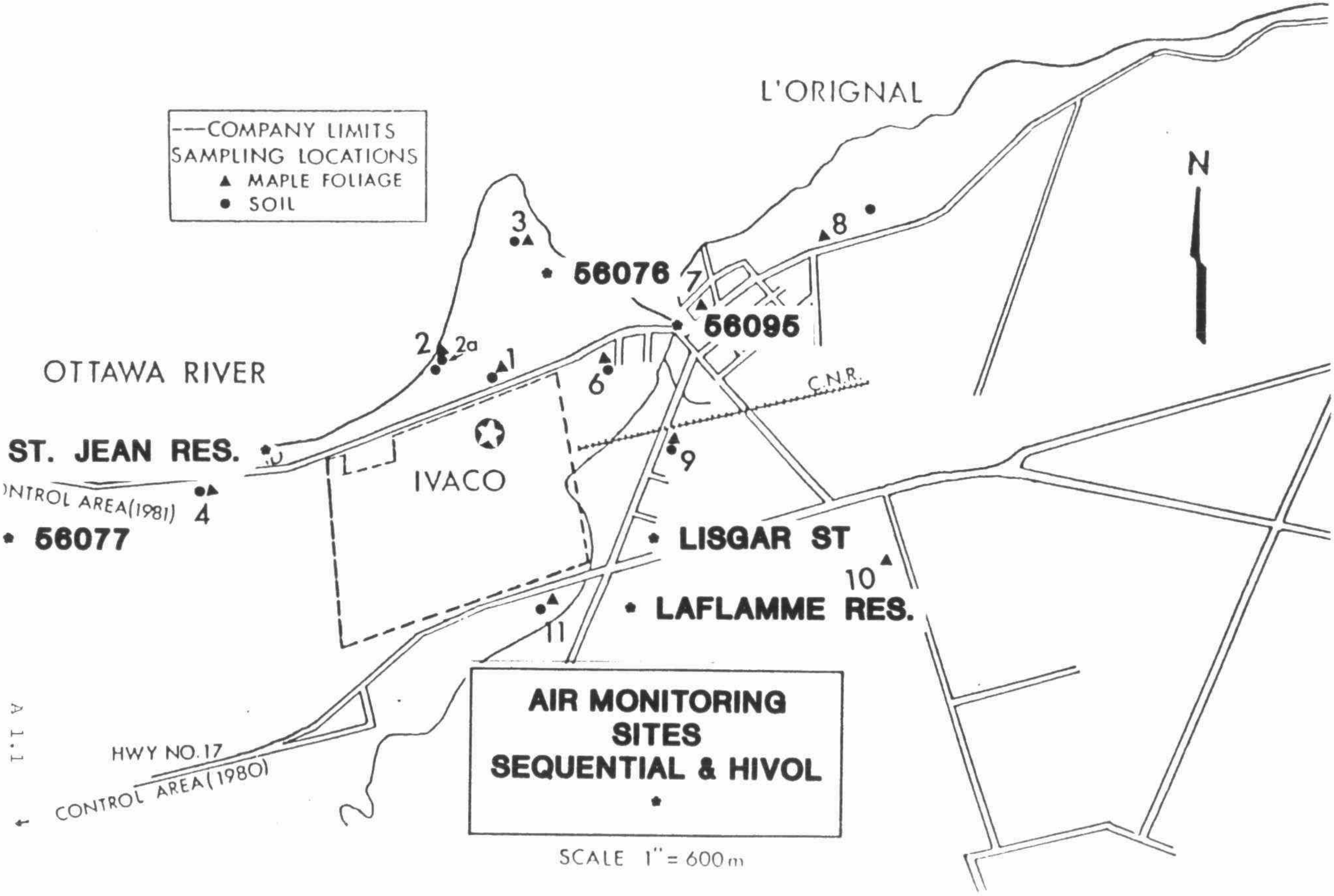
L'ORIGNAL AIR MONITORING SURVEY
24 HOUR AMBIENT AIR QUALITY CRITERIA

CONTAMINANT	AVERAGE CONCENTRATION (MICROGRAMS / CUBIC METER)
TSP	120
IRON OXIDE	25
CADMIUM	2.0 -ALL FORMS OF CADMIUM-
CHROMIUM	1.5
COPPER	50
LEAD	5.0
MANGANESE	10 -AS MANGANESE COMPOUNDS
	2.5 -AS METALLIC MANGANESE-
NICKEL	2
ZINC	120

APPENDIX 1

MAPS & TABLES

MAP 1 : L'ORIGINAL AND AREA AIR MONITORING AND PHYTOTOXICOLOGY SURVEY SITES



L'ORIGNAL AIR QUALITY SURVEY
CALCULATION OF IRON OXIDE FROM IRON

ANALYSIS OF THE AIR FILTERS AT THIS SITE PRODUCED ELEMENTAL CONCENTRATIONS OF METALLIC COMPONENTS. METALLIC OXIDES IN SAMPLES MUST BE COMPUTED BY ADDING UP THE CONTRIBUTION OF OXYGEN ATOMS AND PRODUCING A MULTIPLICATIVE CORRECTION.

IRON : MOLECULAR WEIGHT 56
OXYGEN : ATOMIC WEIGHT 16

IRON OXIDE : FE_2O_3 MOLECULAR WEIGHT = 2*56 + 3 *16
=160

IRON OXIDE / 2 * IRON =1.42857

CORRECTION FACTOR : MULTIPLY IRON BY 1.42857 TO YIELD IRON OXIDE VALUES

LORIGNAL AIR QUALITY SURVEY-SOUTHEASTERN REGION
AIR QUALITY ASSESSMENT UNIT

YR=1977 STATION=56076

DATE	TOTAL SUSPENDED PARTICULATE	IRON OXIDE	LEAD	CHROMIUM
03JUN77	13	0.57	0.10	0.006
06JUN77	15	0.43	0.00	0.005
09JUN77	10	0.29	0.10	0.004
12JUN77	18	0.43	0.10	0.006
15JUN77	22	0.71	0.10	0.004
18JUN77	27	0.43	0.10	0.008
06JUL77	36	0.86	0.10	0.000
04SEP77	22	0.43	0.10	0.005
16SEP77	35	2.14	0.60	0.022
22SEP77	18	0.57	0.10	0.005
28SEP77	14	0.29	0.10	0.005
01OCT77	.	0.29	0.10	0.008
07OCT77	9	0.29	0.10	0.005
13OCT77	11	0.43	0.10	0.006
19OCT77	23	0.43	0.10	0.005
25OCT77	56	1.43	0.50	0.010
31OCT77	47	1.14	0.30	0.009
06DEC77	16	0.43	0.00	0.005
12DEC77	22	0.29	0.40	0.014
18DEC77	20	0.29	0.30	0.005
24DEC77	44	0.86	0.40	0.005
30DEC77	29	0.29	0.40	0.005

YR=1977 STATION=56077

DATE	TOTAL SUSPENDED PARTICULATE	IRON OXIDE	LEAD	CHROMIUM
03JUN77	10	0.29	0.10	0.004
04JUN77	.	0.29	.	.
06JUN77	26	0.86	0.10	0.001
09JUN77	12	0.29	0.10	0.003
12JUN77	31	0.57	0.10	0.004
15JUN77	21	0.57	0.10	0.005
18JUN77	37	2.14	0.60	0.010
21JUN77	16	0.29	0.10	0.003
24JUN77	34	1.00	0.20	0.006
27JUN77	30	.	.	.
30JUN77	21	0.29	0.00	0.000
03JUL77	.	0.57	0.10	0.001
06JUL77	28	0.57	0.10	0.004
09JUL77	19	0.43	0.10	0.000
12JUL77	42	1.57	0.40	0.009
15JUL77	30	0.29	0.10	0.000
18JUL77	28	0.57	0.10	0.000
21JUL77	23	0.29	0.10	0.000
24JUL77	28	2.14	0.80	0.002
27JUL77	15	2.42	1.60	0.015
11AUG77	34	2.28	1.10	0.015

ALL MEASUREMENTS ARE IN MICROGRAMS PER CUBIC METER

LORIGNAL AIR QUALITY SURVEY-SOUTHEASTERN REGION
AIR QUALITY ASSESSMENT UNIT

-- YR=1977 STATION=56077 --

DATE	TOTAL SUSPENDED PARTICULATE	IRON OXIDE	LEAD	CHROMIUM
14AUG77	29	1.14	0.80	0.061
17AUG77	16	1.43	1.40	0.048
04SEP77	22	1.00	0.10	0.011
10SEP77	36	0.86	0.10	0.006
16SEP77	64	.	.	.
22SEP77	23	1.28	0.30	0.011
28SEP77	11	0.29	0.10	0.005
01OCT77	8	.	.	.
12NOV77	6	0.29	0.00	0.000
18NOV77	13	0.29	0.10	0.005
24NOV77	17	0.43	0.20	0.000
30NOV77	37	0.57	0.40	0.005
06DEC77	17	0.29	0.00	0.000
12DEC77	16	0.43	0.00	0.024
18DEC77	20	0.29	0.40	0.003
24DEC77	16	2.14	0.20	0.000

-- YR=1978 STATION=56076 --

DATE	TOTAL SUSPENDED PARTICULATE	IRON OXIDE	LEAD	CHROMIUM
23JAN78	.	0.14	0.10	0.003

-- YR=1978 STATION=56077 --

DATE	TOTAL SUSPENDED PARTICULATE	IRON OXIDE	LEAD	CHROMIUM
01JAN78	.	0.00	0.20	0.000
02JAN78	13	.	.	.
20JAN78	14	1.00	0.20	0.005
26JAN78	18	1.14	0.00	0.006
01FEB78	25	.	.	.
02FEB78	.	0.14	0.00	0.003
07FEB78	19	0.29	0.00	0.005
13FEB78	19	0.14	0.00	0.003
25FEB78	13	.	.	.
03MAR78	52	.	.	.
09MAR78	25	0.29	0.00	0.007
15MAR78	14	0.29	0.00	0.004
21MAR78	46	5.42	0.10	0.022
27MAR78	11	1.57	0.00	0.009
02APR78	11	0.43	0.00	0.004
08APR78	22	0.43	0.00	0.002
14APR78	19	0.29	0.00	0.003
20APR78	10	0.29	0.00	0.003
02MAY78	44	2.14	0.00	0.008

ALL MEASUREMENTS ARE IN MICROGRAMS PER CUBIC METER

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                    LORIGNAL AIR QUALITY SURVEY-SOUTHEASTERN REGION
                               AIR QUALITY ASSESSMENT UNIT

------------------------------------------------ YR=1978 STATION=56077 ------------------------------------------------

                    DATE    TOTAL SUSPENDED     IRON OXIDE    LEAD    CHROMIUM
                              PARTICULATE

                 08MAY78                 51           1.85    0.00       0.008


------------------------------------------------ YR=1979 STATION=56076 ------------------------------------------------

                    DATE    TOTAL SUSPENDED     IRON OXIDE    LEAD    CHROMIUM
                              PARTICULATE

                 09JUL79                  .           2.99    0.10       0.013
                 10JUL79                  .           1.57    0.10       0.006
                 11JUL79                  .           1.57    0.10       0.006
                 12JUL79                  .           1.43    0.20       0.006
                 16JUL79                  .           2.57    0.10       0.013
                 17JUL79                 24           1.00    0.10       0.006
                 18JUL79                 51           1.71    0.10       0.006
                 19JUL79                 80           2.42    0.20       0.006
                 22JUL79                 89           2.14    0.20       0.006
                 23JUL79                 77           1.71    0.10       0.006
                 24JUL79                 77           2.57    0.10       0.006
                 25JUL79                 61             .       .          .
                 30JUL79                 52             .       .          .
                 31JUL79                 67             .       .          .
                 01AUG79                 30             .       .          .
                 02AUG79                 42             .       .          .
                 07AUG79                 44             .       .          .
                 08AUG79                 47             .       .          .
                 09AUG79                 29           0.29    0.10       0.000




                       ALL MEASUREMENTS ARE IN MICROGRAMS PER CUBIC METER
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L'Orignal Air Quality Survey
September 1984 - Station 56095

SAMPLE DESIGNATION AND DATE	IRON OXIDE	LEAD	CHROMIUM	ZINC	CADMIUM	MANGANESE	COPPER
3 84/09/07	6.89	0.89	0.00	0.63	0.00	0.21	0.00
4 84/09/08	20.14	0.73	0.14	1.24	0.00	0.58	0.00
5 84/09/09	4.50	0.00	0.04	0.35	0.00	0.15	0.00
6 84/09/10	3.94	0.22	0.03	0.21	0.00	0.15	0.00
7 84/09/11	7.00	0.80	0.06	0.39	0.00	0.33	0.00
10 84/09/13	8.57	1.14	0.09	0.78	0.00	0.51	0.00
11 84/09/14	3.24	0.160	0.04	0.22	0.00	0.12	0.00
12 84/09/15	7.00	0.710	0.05	0.30	0.00	0.22	0.00
13 84/09/16	8.57	0.550	0.05	0.55	0.00	0.13	0.00
14 84/09/17	3.24	1.12	0.12	1.71	0.00	0.78	0.09
15 84/09/18	5.08	1.19	0.14	2.87	0.00	0.88	0.10
16 84/09/19	6.49	1.18	0.12	1.34	0.00	0.59	0.00
17 84/09/20	16.14	0.79	0.05	0.29	0.00	0.14	0.00
18 84/09/21	18.57	1.35	0.06	0.53	0.00	0.27	0.09
19 84/09/22	17.29	0.46	0.04	0.33	0.00	0.15	0.00
20 84/09/23	8.64	1.58	0.17	0.62	0.00	0.34	0.00
21 84/09/24	19.00	0.67	0.13	1.47	0.00	0.87	0.14
21A 84/09/25	3.57	0.57	0.00	0.20	0.00	0.11	0.00
22 84/09/26	3.57	0.00	0.00	0.00	0.00	0.00	0.00
23 84/09/27	11.39	1.06	0.11	0.85	0.00	0.48	0.00
24 84/09/28	6.86	0.89	0.06	0.94	0.00	0.29	0.00

ALL SAMPLES ARE REPORTED
IN MICROGRAMS PER CUBIC METER

L'Orignal Air Quality Survey
September 1984 - Station 56095

SAMPLE DESIGNATION AND DATE	IRON OXIDE	LEAD	CHROMIUM	ZINC	CADMIUM	MANGANESE	COPPER
25 84/09/29	3.00	1.08	0.01	0.19	0.00	0.13	0.00
26 84/09/30	5.20	1.65	0.04	0.25	0.00	0.22	0.15
27 84/10/01	6.41	1.23	0.04	0.43	0.00	0.26	0.00
28 84/10/02	6.37	1.37	0.06	0.29	0.00	0.44	0.00
29 84/10/03	4.90	0.46	0.04	0.47	0.00	0.22	0.00
30 84/10/04	3.64	0.34	0.04	0.16	0.00	0.15	0.00
31 84/10/05	8.99	1.06	0.07	0.70	0.00	0.36	0.00
32 84/10/06	6.21	1.67	0.06	0.57	0.00	0.26	0.00
33 84/10/07	5.06	1.41	0.08	0.44	0.00	0.24	0.00
34 84/10/08	3.34	0.54	0.00	0.14	0.00	0.12	0.00
35 84/10/09	8.38	0.92	0.07	0.27	0.00	0.28	0.00
36 84/10/10	11.23	1.50	0.10	0.86	0.00	0.43	0.00
1001 84/10/13	13.87	1.25	0.09	1.23	0.00	0.56	0.00
1002 84/10/14	8.43	2.02	0.07	0.50	0.00	0.39	0.00
1003 84/10/14	7.83	1.52	0.06	0.85	0.00	0.37	0.00
1004 84/10/15	11.09	3.11	0.10	0.52	0.00	0.36	0.00
1005 84/10/16	9.20	1.93	0.08	0.37	0.00	0.27	0.00
1006 84/10/17	7.57	0.97	0.09	0.21	0.00	0.25	0.12
1007 84/10/18	8.91	1.65	0.08	0.31	0.00	0.24	0.00
1008 84/10/19	14.57	1.81	0.09	0.53	0.00	0.49	0.00

ALL SAMPLES ARE REPORTED
IN MICROGRAMS PER CUBIC METER

L'Orignal Air Monitoring Survey
Hivol and Sequential sampler comparison

DATE	HIVOL T.S.P.	SEQUENTIAL T.S.P.
84/08/31	87	
84/09/07	31	49
84/09/12	25	
84/09/18	57	75.8
84/09/21	38	45.1
84/09/26	27	18.2

UNITS: MICROGRAMS PER CUBIC METER

L'Orignal Air Quality Survey
July 1987

SAMPLE DESIGNATION AND DATE	IRON OXIDE	LEAD	CHROMIUM	ZINC	CADMIUM	MANGANESE	COPPER
87 87/07/30	0.261	0.00	0.00	0.00	0.00	0.21	0.00
88 87/07/31	0.404	0.00	0.00	0.00	0.00	0.58	0.00
89 87/08/01	0.643	0.00	0.00	0.03	0.00	0.15	0.00
90 87/08/02	0.396	0.00	0.00	0.00	0.00	0.15	0.00
91 87/08/03	0.686	0.00	0.00	0.03	0.00	0.33	0.00
92 87/07/30	0.609	0.00	0.00	0.00	0.00	0.51	0.00
93 87/08/01	0.647	0.00	0.00	0.00	0.00	0.12	0.00
94 84/08/02	1.614	0.00	0.00	0.05	0.00	0.22	0.00
95 84/08/03	0.926	0.00	0.03	0.05	0.00	0.13	0.00
96 84/07/30	0.336	0.00	0.00	0.00	0.00	0.78	0.09
97 84/07/31	1.201	0.00	0.00	0.05	0.00	0.88	0.10

ALL SAMPLES ARE REPORTED
IN MICROGRAMS PER CUBIC METER

L'Orignal Air Quality Survey
DECEMBER 1987 - LAFLAMME STATION

SAMPLE DESIGNATION AND DATE	IRON OXIDE	LEAD	CHROMIUM	ZINC	CADMIUM	MANGANESE	COPPER
33 87/07/30	0.314	0.00	0.00	0.00	0.00	0.00	0.00
34 87/07/31	2.214	0.00	0.06	0.26	0.00	0.16	0.00
35 87/08/01	4.686	0.00	0.00	0.69	0.00	0.05	0.00
36 87/08/02	3.686	0.00	0.00	0.54	0.00	0.04	0.00
37 87/08/03	4.329	0.00	0.06	0.52	0.00	0.30	0.00
38 87/07/30	4.643	0.00	0.06	0.69	0.00	0.28	0.00
45 87/08/01	0.186	0.00	0.00	0.07	0.00	0.04	0.00
46 84/08/02	0.114	0.00	0.00	0.00	0.00	0.26	0.00
47 84/08/03	0.000	0.00	0.03	0.00	0.00	0.06	0.00
51 84/07/30	0.000	0.00	0.00	0.00	0.00	0.00	0.09

ALL SAMPLES ARE REPORTED
IN MICROGRAMS PER CUBIC METER

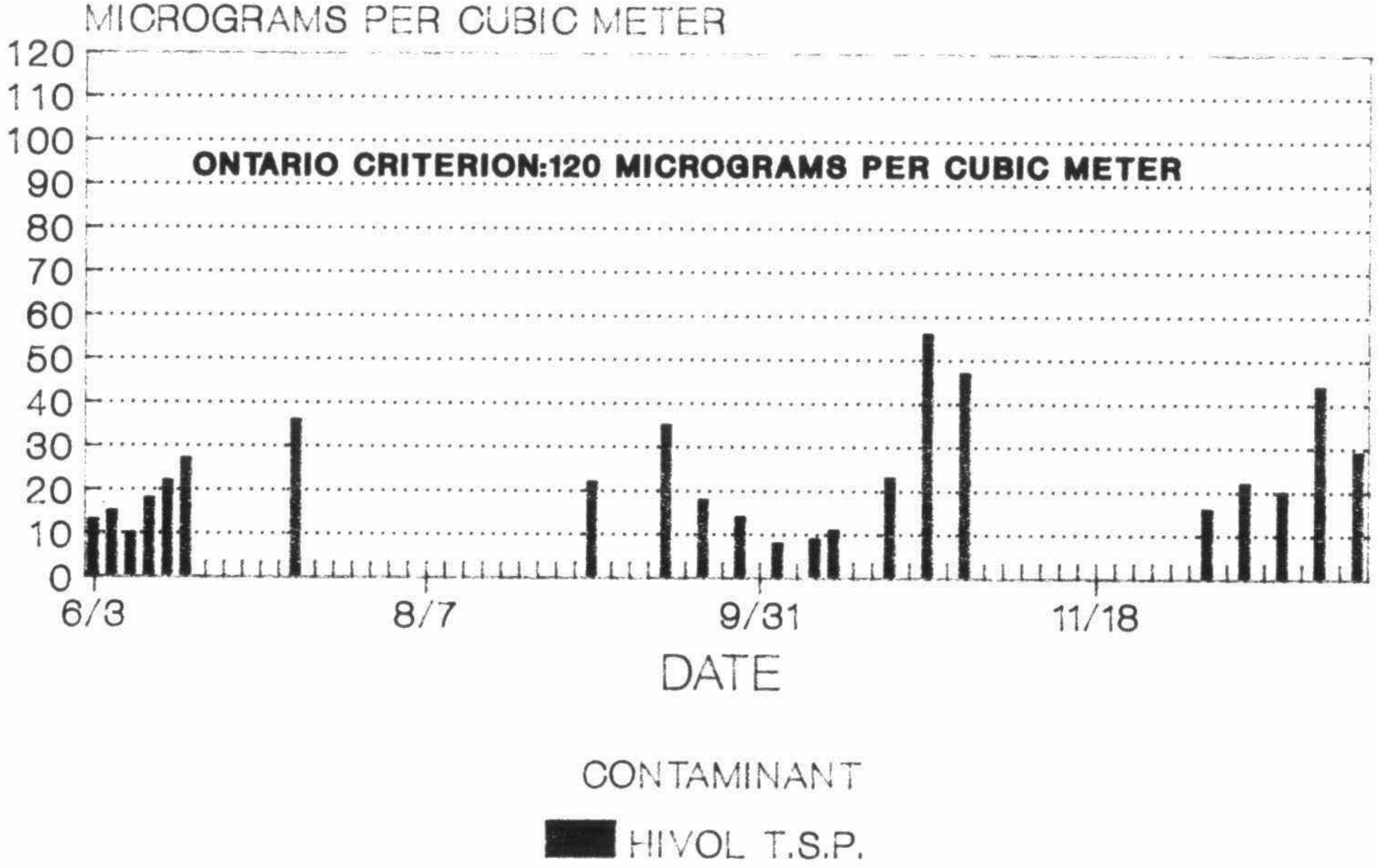
L'Orignal Air Quality Survey
DECEMBER 1987 - LISGAR STATION

SAMPLE DESIGNATION AND DATE	IRON OXIDE	LEAD	CHROMIUM	ZINC	CADMIUM	MANGANESE	COPPER
39 87/12/05	1.99	0.00	0.03	0.21	0.00	0.00	0.00
40 87/12/06	3.63	0.00	0.04	0.50	0.00	0.16	0.00
41 87/12/07	1.90	0.00	0.03	0.30	0.00	0.05	0.00
42 87/12/08	1.31	0.00	0.03	0.08	0.00	0.04	0.00
43 87/12/09	0.31	0.00	0.06	0.10	0.00	0.30	0.00
44 87/12/09	0.00	0.00	0.06	0.00	0.00	0.28	0.00
52 87/12/10	0.54	0.00	0.00	0.07	0.00	0.04	0.00
53 87/12/11	0.33	0.00	0.00	0.05	0.00	0.26	0.00
54 87/12/12	0.24	0.00	0.03	0.00	0.00	0.06	0.00
55 87/12/13	0.30	0.00	0.00	0.05	0.00	0.00	0.00
56 87/12/14	0.27	0.00	0.00	0.05	0.00	0.38	0.00
57 87/12/15	0.26	0.00	0.00	0.04	0.00	0.36	0.00
58 87/12/16	0.00	0.00	0.00	0.00	0.00	0.00	0.00

ALL SAMPLES ARE REPORTED
IN MICROGRAMS PER CUBIC METER

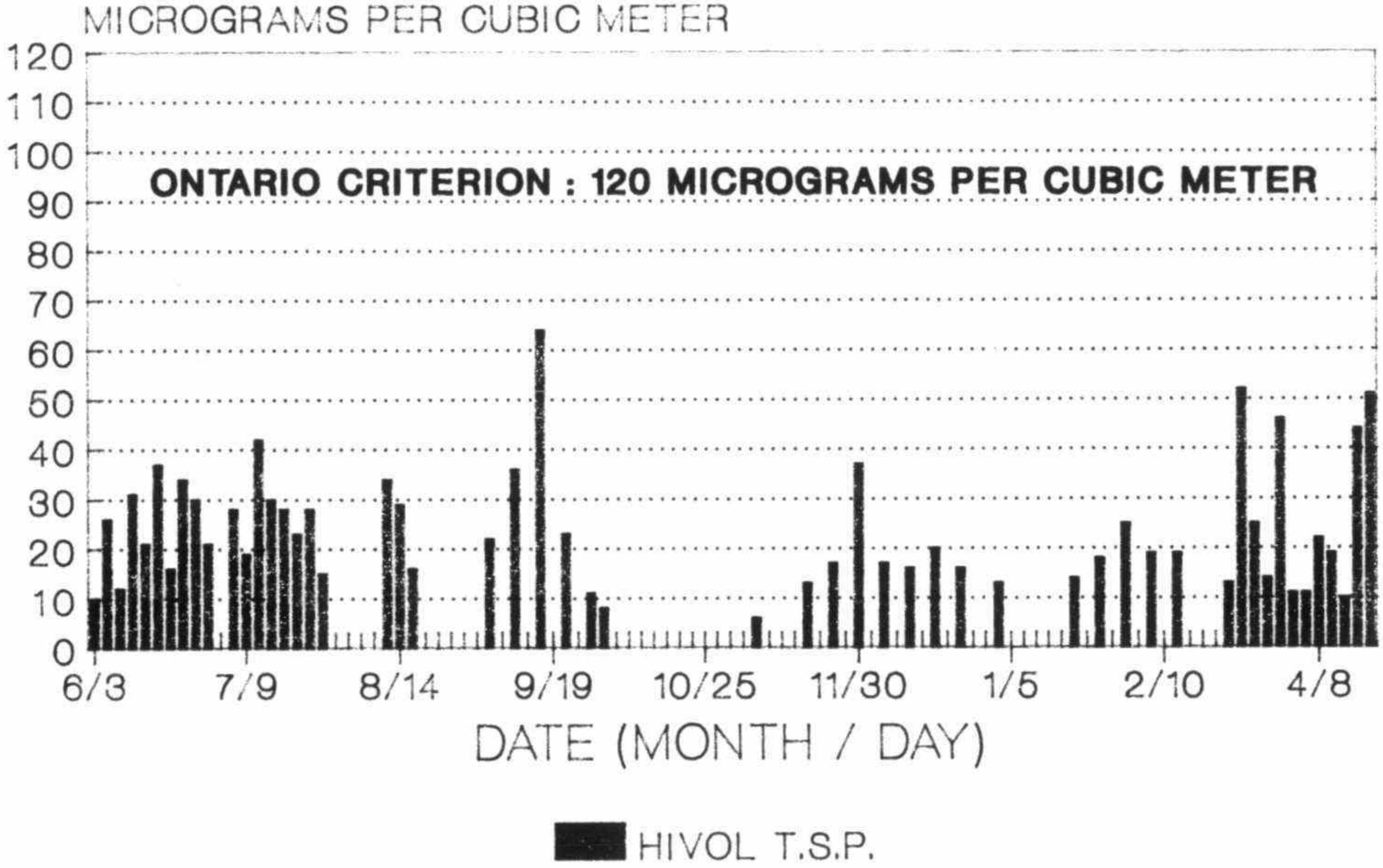
APPENDIX 2
CHARTS

L'ORIGNAL AIR MONITORING SURVEY-1977
24 HOUR HIVOL T.S.P.- STATION 56076



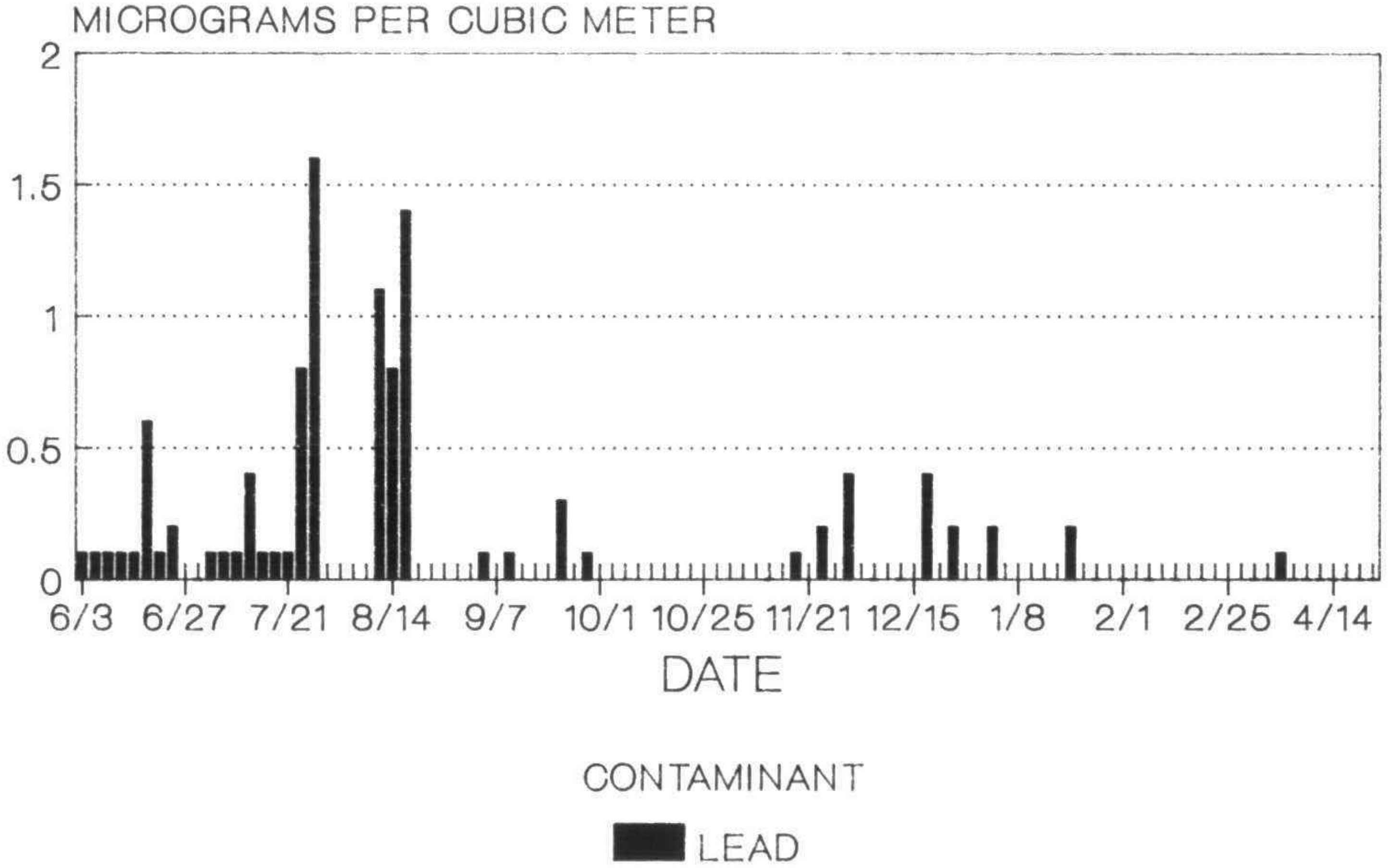
JUNE 1977 TO DECEMBER 1977

L'ORIGNAL AIR MONITORING 1977-1978
24 HOUR HIVOL T.S.P.- STATION 56077



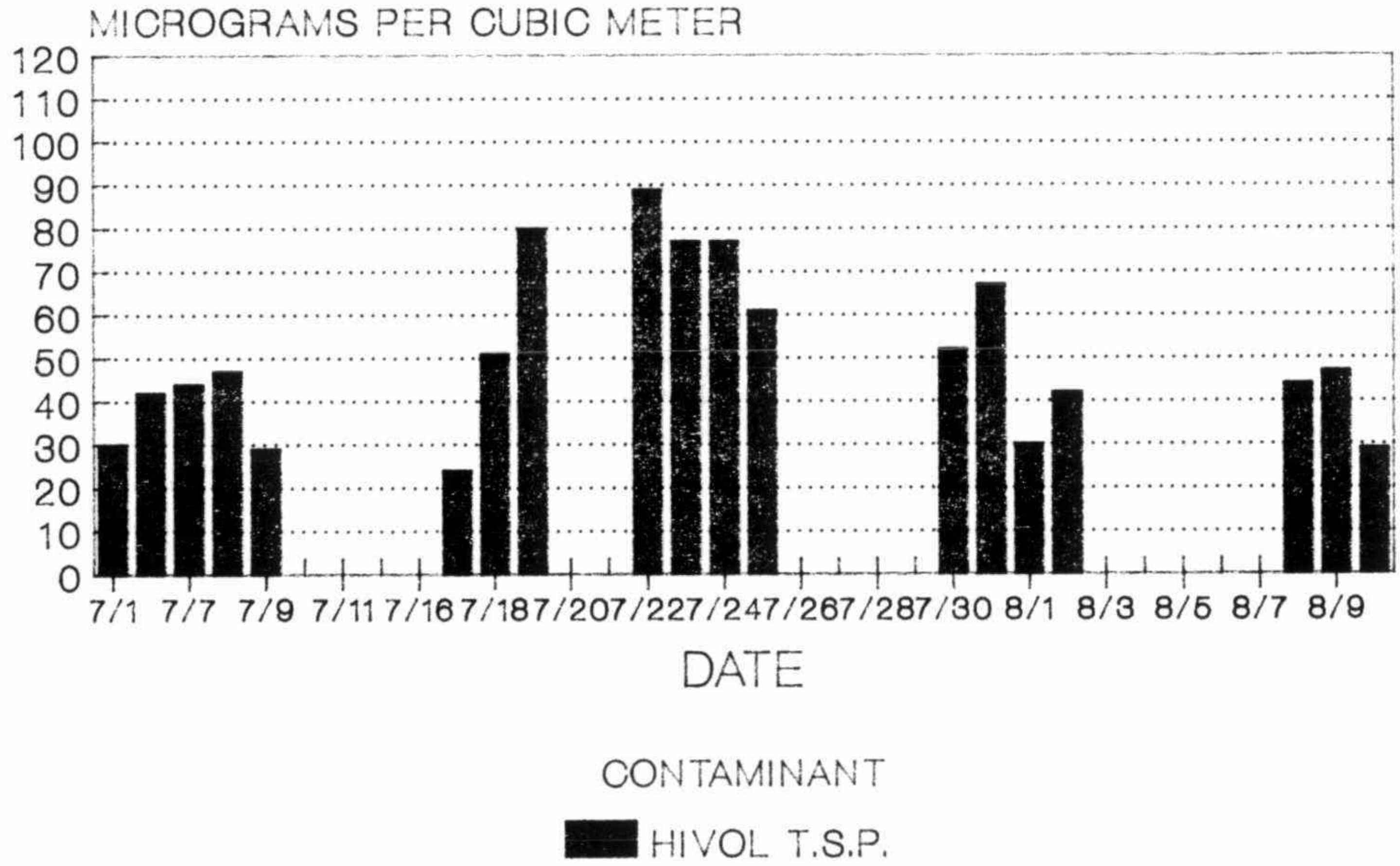
JUNE 1977 TO MAY 1978

L'ORIGNAL AIR MONITORING 1977-1978
24 HOUR HIVOL METALS- STATION 56077



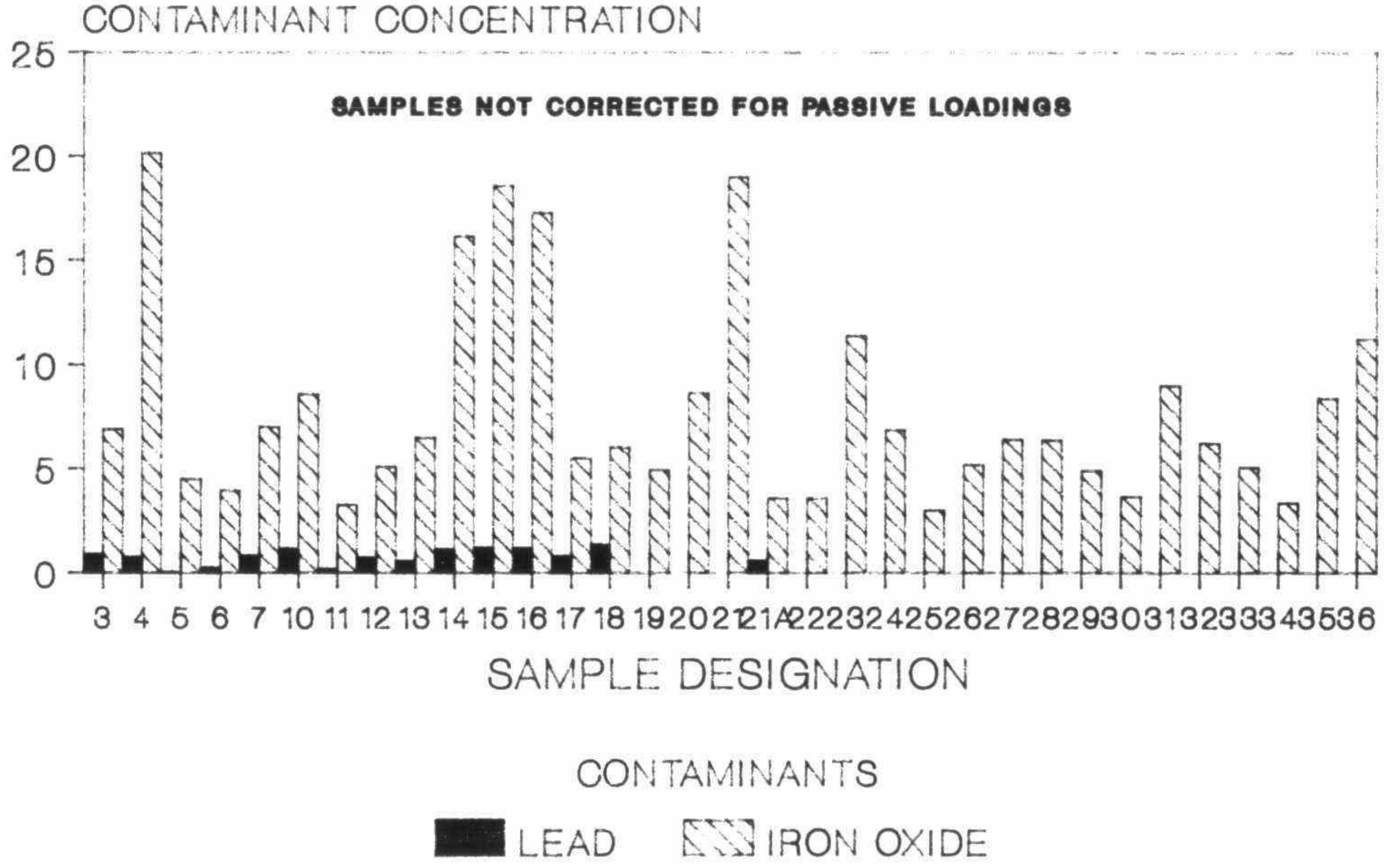
JUNE 1977 TO MAY 1978

L'ORIGNAL AIR MONITORING SURVEY
1979 SUMMER HIVOL DATA -STATION 56076



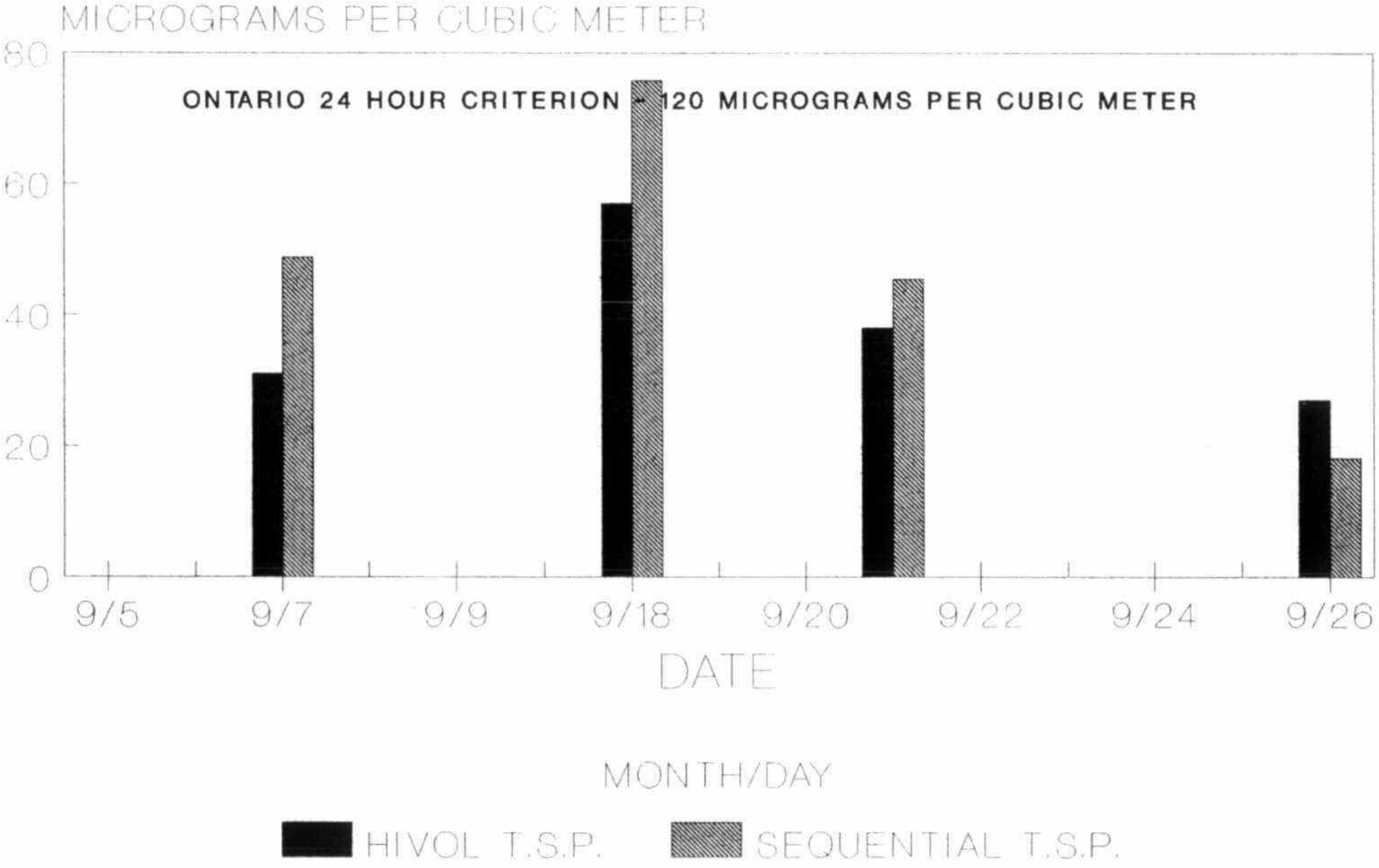
JULY-AUGUST 1979

L'ORIGNAL AIR MONITORING SURVEY
SEQUENTIAL SAMPLE RESULTS-SEPTEMBER 1984



UNITS - MICROGRAMS PER CUBIC METER

L'ORIGNAL AIR MONITORING SURVEY
HI-VOLUME & SEQUENTIAL DATA SEPT. 1984



SEQUENTIAL TSP IS THE SUM OF THE MAJOR
ELEMENTAL COMPONENTS OF THE SEQUENTIAL DATA

APPENDIX 3

PHYTOXICOLOGY ASSESSMENTS
1980-1986

Ministry of the Environment
Ministère de l'Environnement
Ontario

ENVIRONMENT – ONTARIO
KINGSTON – ONTARIO

Air Resources Branch
Phytotoxicology Section
880 Bay Street, Suite 347
Toronto, Ontario
M5S 1Z8

135 St. Clair Avenue West
Suite 100
Toronto, Ontario
M4V 1P5

135 ouest, avenue St. Clair
Bureau 100
Toronto (Ontario)
M4V 1P5

ARB No: ARB-82-86-Phyto
Date: March 12, 1986
Author: Bob Emerson

Results of Phytotoxicology Sampling Programs Conducted in the Vicinity of IVACO, L'Orignal during 1984 through April 1985.

SAMPLES COLLECTED PRIOR TO 1984

The initial maple foliage and soil sampling programs in the vicinity of the IVACO metal recycling plant, L'Orignal, were conducted by the Phytotoxicology Section in 1980, with follow-up foliage sampling being performed in 1981 and 1983, at the request of Mr. G. Murphy, MOE, Cornwall. The analytical results for these collections suggested that IVACO was a minor source of metal emissions.

A. SAMPLES COLLECTED DURING 1984 THROUGH APRIL 1985

1) Maple Foliage and Soil Sampling – August 28, 1984

In late August, 1984 maple foliage was collected from the exposed side (facing IVACO) of all regular collection sites as well as from the property (Site I) sampled to the immediate north of IVACO in 1980. Since 1981, corresponding maple foliage samples also have been collected from a control area off Bay Road, to the remote west of IVACO. (See attached Figure 1)

Surface soil (0-5 cm) was additionally collected at all but three of the sites sampled in 1980. The exceptions were Sites 2, 5 and the 1980 control site. In

1984, Site 2 was replaced by Site 2a which was closer to the foliage collection site in this area. Soil collection Site 5 was discontinued, and the 1980 control site was replaced by The Bay Road Control Site. (See Figure 1)

As in previous years, Mr. G. Murphy, MOE, Cornwall assisted with the sampling.

2) Moss Bag Survey - October 10, 1984 through April 23, 1985

In mid-October, 1984, a single moss bag was placed at a height of about 3 meters (10') on each of five hydro/telephone poles situated at increasing distances to the east and south of IVACO, as well as at a control site to the remote west (see attached Figure 2). The bags were replaced approximately every 30 days through to April, 1985 by Mr. G. Murphy, MOE, Cornwall.

3) Snow Sampling - February 28, 1985

On February 28, 1985, the writer and Mr. R. Rinne, Phytotoxicology Section, collected snow from two locations close to IVACO's eastern boundary and from two more remote locations (see Figure 2).

At all locations, the vertical snow profile at two sites was sampled down to ground level using a cylindrical dustfall bucket with a handle attached at the closed end. The inside diameter of the opposite open end plunged into the snow was 15 cm (6") with the sampling depth, based on all sites, ranging from 29 to 35 cm. The snow collected from each site was immediately emptied into a clean garbage bag, previously placed inside a clean plastic pail for support. The open end of the bag was tied to eliminate any contamination during transporting.

SAMPLE PROCESSING AND ANALYSIS

1) Foliage, Soil, Moss

All foliage, soil and moss samples first were dried and ground in the Phytotoxicology Processing Laboratory. The samples then were submitted to the Inorganic Trace Contaminants Section, Laboratory Services Branch, MOE, for analysis of all elements shown in respective Tables 1-4.

2) Snow Samples

All snow samples were returned to the Phytotoxicology Processing Laboratory where they were melted at room temperature. After melting was complete, floating vegetation (weed/grass pieces) was removed, the water volume of all samples was equalized and then all liquid samples were filtered simultaneously. After filtering, each sample of wet filter paper together with the collected material was folded, placed in a petrie dish and covered and then dried at room temperature. Following drying, each sample of filter paper and particulate was weighed, then all samples were submitted to the Inorganic Trace Contaminants Section, Laboratory Services Branch to be analyzed for all elements shown in Table 5. Blank filter papers also were weighed and analyzed.

B. DISCUSSION OF ANALYTICAL RESULTS

Revisions to Former Phytotoxicology Excessive Levels

In 1984, the "Phytotoxicology excessive levels" shown in previous reports were revised and new contaminant guidelines, referred to as "upper limits of normal" were developed by the Phytotoxicology Section.

The MOE "upper limits of normal" shown in the attached tables represent the expected maximum concentrations of contaminants in foliage, non agricultural soil (0-5 cm), and moss bags from areas of Ontario not subject to the influence of point sources of emissions. These guidelines were developed for both rural (non built-up) and urban (minimum 10,000 population) areas, and the IVACO survey area, based on population, falls into the rural area designation. The "upper limits of normal", were calculated by taking the arithmetic mean of available analytical data and adding three standard deviations of the mean. It is stressed that these guidelines do not represent maximum desirable or allowable levels of contaminants. Moreover, concentrations which exceed the guidelines are not necessarily toxic to plants, animals or man; however, concentrations below the guidelines are not known to be toxic.

In the following discussions, the foliage, soil and moss results are compared to the respective new "Upper Limits of Normal" guidelines which replace the former "Phytotoxicology excessive levels". No contaminant guidelines for particulate matter alone in snow have been developed by the MOE.

ANALYTICAL RESULTS FOR SAMPLES COLLECTED DURING THE 1984 GROWING SEASON

1) Unwashed Maple Foliage Results (see attached Table 1)

The foliage samples collected in 1984 were analyzed for cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), nickel (Ni), zinc (Zn), iron (Fe), molybdenum (Mo) and vanadium (V). In most cases, the higher foliar concentrations were detected at either Site 1 (to the N), Site 6 (to the ENE) or Site 11 (to the SSE). All but two of the elements (Cu and V) displayed a decreasing trend with increasing distance from IVACO.

With exception of Cu and V, the higher levels of all elements were, in most cases, several times higher than the corresponding control levels. However, only the foliar Fe concentrations detected at Site 1 (765 ppm), Site 6 (640 ppm) and Site 11 (725 ppm) were found to slightly exceed the respective upper limit of normal for a rural area.

Slightly excessive foliar iron levels also were documented in 1983 and 1980 at two collection sites. In previous years, none of the other elements were found to be excessive with exception of zinc at foliage site 11 in 1983. Unlike the Cd, Cu, Cr, Pb, Ni, and Zn results, foliar levels of Fe were slightly increased throughout the survey area in 1984 compared to the previous years' results.

2) Soil Results (see attached Table 2)

Like the foliage samples, all soil samples collected in 1984 were analyzed for nine heavy metals (Cd, Cr, Cu, Pb, Ni, Zn, Fe, Mo, Vn). As with foliage, the higher concentrations of most metals were detected at collection sites in the immediate area of IVACO. The results for all elements (with exception of Mo) displayed a trend of decreasing concentration with increasing distance.

The highest soil concentrations of all elements (excluding Mo) were, as in 1980, detected at Site 11 to the SSE. Soil concentrations of most metals at Sites 1 (to the N) and 2a (to the NW) also were elevated compared to the levels detected at other sites including the control site. However, when the soil results were compared to the respective upper limits of normal for a rural area, only the levels of Cr at Site 11 (95 ppm), Site 1 (64 ppm), and Site 2a (88 ppm) were found to be slightly excessive in relation to the respective guideline (50 ppm).

Compared to the Cd, Cr, Cu, Pb, Ni and Zn results for 1980, the soil concentrations of these elements detected at corresponding sampling sites in 1984 were fairly similar.

ANALYTICAL RESULTS FOR SAMPLES COLLECTED DURING THE 1984-85 FALL AND WINTER

1) Moss Bag Survey Results (see attached Tables 3 and 4)

As was the case with the foliage and soil samples collected in 1984, the six moss bags collected from the survey area at the end of each 30-day exposure period during October, 1984 through April, 1985 were analyzed for the following elements -Cd, Cr, Cu, Fe, Pb, Mo, Ni, V and Zn.

The concentrations of all elements at the end of each exposure period (with exception of V in January) were higher at sites to the immediate E and/or S of IVACO than at more remote sites. The highest metal concentrations usually were detected at either moss Site 1 (to the NNE) or Site 3 (to the SSE) in the vicinity of foliage and soil collection Sites 6 and 11, respectively.

As shown in Tables 3 and 4, upper limits of normal have been developed for all but two (Mo and V) of the metals. The higher moss concentrations of Cd, Cr, Cu, Fe, Pb and Zn detected during October, 1984 through April, 1985 were greater than the respective rural guidelines. The highest moss levels of Cr (10-18 ppm), Fe (3,600-4,400 ppm) and Zn (810; 1,300) also exceeded the respective guidelines for an urban area. Moreover, considering that Cr and Fe were the only elements to consistently exceed the respective urban guidelines, it would appear that IVACO emissions were a more significant source of Cr and Fe than of the other metals during the 1984-85 Fall through Winter (see Table 4).

2) Snow Sampling Results (see attached Table 5)

The snow sampling by Messrs. Emerson and Rinne on February 28, 1984 was conducted in light of the elevated lead level found in the suspended material filtered from a snow sample collected by Mr. W. Kaeppner of the Longueuil Citizen's Association on March 24, 1984.

Mr. Kaeppner's Results

Mr. Kaeppner collected the sample 60 m (200') north of Hwy 17 along IVACO's eastern boundary. The sample represented snowfall from mid-December, 1983 through to the end of March (1984). He further reported that the snow in the sampling area had a grey colour in March. Following collection, the snow sample was allowed to melt and the suspended material was filtered, weighed and sent to a commercial lab for analysis of Pb, Cd and Cr. Mr. Kaeppner reported that the suspended material contained 2.23% Pb, 0.02% Cd and 0.11% Cr. Converting these results to parts per million (ug/g) equates to 22,300 ppm Pb, 200 ppm Cd and 1,100 ppm Cr.

MOE Snow Sampling Program and Results

The MOE snow sampling was conducted on February 28, 1985 one month earlier than the sampling in 1984 by Mr. Kaeppner. As indicated earlier, snow samples were collected at two locations (Sites 1 and 2) just east of IVACO's eastern boundary and at two more remote sites (Sites 3 and 4). Site 1 was believed to be in the same general area where Kaeppner collected his snow sample in 1984.

The samples were melted, then filtered and each sample of filter paper plus the collected material was analyzed on a dry weight basis for Cd, Cr, Cu, Fe, Pb, Ni and Zn. The average concentration of each metal detected in the particulate material alone filtered from the two snow samples collected at each site are shown in attached Table 5.

This Table shows a clear pattern of higher metal particulate loading in the snow at Sites 1 and 2, closest to IVACO, suggesting that IVACO emissions had contributed.

Like Kaeppner's snow sampling results, the MOE data revealed a higher fraction of Pb than of Cd or Cr in the particulate filtered from the snow collected at Site 1. However, in contrast, the concentrations of Pb (1,954 ppm) and of Cd (28 ppm) detected in the snow particulate at this site in 1985 were about 10 and 6 times lower, respectively, than the corresponding Pb (22,300 ppm) and Cd (200 ppm) levels found by Kaeppner in this area in 1984. The Cr level of 1,117 ppm detected at snow collection Site I in 1985 was similar to the Cr level of 1,100 ppm found by Mr. Kaeppner.

In March 1984, Kaeppner observed that the snow in the vicinity of Site I was greyish in colour. In contrast, the snow collected here by the writer and Mr. Rinne in February, 1985 did not display any unusual discolouration. Hence, the possibility that the snow was dirtier in this area in 1984 and the fact that the snow sampling in 1984 was conducted one month later than in 1985 may have contributed to the higher levels found by Mr. Kaeppner.

However, the Pb results of all Phytotoxicology sampling programs which have been conducted since 1980 indicate that IVACO is only a minor source of lead emissions.

No contaminant guidelines for particulate matter alone in snow have been developed by the MOE for the snow sampling and handling procedures described in this report. However, in light of Kaeppner's high Pb finding, and as the MOE has developed a guideline for Pb in dustfall, we recommend that a dustfall monitor be placed adjacent to the SE corner of the IVACO property to determine the actual Pb content of dustfall in the area where Mr. Kaeppner collected his snow sample.

C. SUMMARY

1) Foliage, Soil and Moss Results

In summary, the recent foliage, soil and moss bag results indicate that IVACO's metal recycling operations are a potential emission source of at least nine heavy metals - Cd, Cr, Cu, Fe, Pb, Mo, Ni, V, and Zn. Based on the 1984-85 results and the earlier years' analytical data, it would appear that Cr and Fe are the primary elements being emitted.

On the basis of the recent data, the only exceedances of the Phytotoxicology Upper Limits of Normal were for Fe in foliage and Cr in soil. In moss, the highest levels of most metals also exceeded the respective rural "Upper Limits of Normal" guidelines, but only the highest levels of Cr, Fe, and Zn were found to exceed the urban guidelines.

As in previous years, the August 1984 tree foliage and soil results suggested that IVACO emissions were a minor source of heavy metal emissions during the growing season. However, in light of the generally higher moss and snow results from collections made during the winter months, it is possible that IVACO emissions are higher during the winter. A moss bag survey will be conducted in 1986 to assess the contaminant deposition during the growing season.

2) Snow Results

The 1985 Phytotoxicology snow sampling results further confirmed that IVACO is an emission source of several metals. All Pb results, however, were much lower than the snow particulate Pb level found near the SE corner of the IVACO property by Kaeppner in 1984. Nevertheless, in light of Mr. Kaeppner's snow results, and as the MOE has a dustfall guideline for Pb, we recommend that a dustfall monitor be placed in the general area where Mr. Kaeppner collected his snow sample.

TABLE 1: ANALYTICAL RESULTS FOR UNWASHED MAPLE FOLIAGE COLLECTED IN THE VICINITY OF IVACO IN AUGUST 1984 COMPARED TO EARLIER YEARS' RESULTS

Site #	Approximate Distance & Direction	Foliage Description	Mean Concentration of Unwashed Maple Foliage - parts per million - dry weight basis															
			Cr				Fe				Pb				Zn			
			1980^{b}	1981^{d}	1983^{b}	1984^{c}	1980^{b}	1981^{d}	1983^{b}	1984^{c}	1980^{b}	1981^{d}	1983^{b}	1984^{c}	1980^{b}	1981^{d}	1983^{b}	1984^{c}
4	1350 m WSW	SM	3	<2	2	3	550	265	267	400	21	11	7	8	112	77	73	65
2*	450 m NW	SM	<2	<2	<1	1	152	130	77	165	4	5	2	2	47	38	25	27
1	265 m N	RM-1980	3	-	-	-	352	-	-	-	11	-	-	-	47	-	-	-
		SUM-1984	-	-	-	5	-	-	-	765	-	-	-	13	-	-	-	45
3	900 m N	SM	<2	<2	2	2	157	150	147	255	3	3	4	4	48	51	47	41
6	675 m ENE	MM	3	<2	3	5	402	250	520	640	21	11	14	12	57	31	57	35
7	1165 m ENE	MM	2	<2	1	2	238	175	180	270	9	4	4	6	26	24	23	21
8**	1800 m ENE	MM	<2	<2	1	2	158	95	101	195	9	4	3	3	20	14	20	18
9	865 m E	MM	2	<2	2	3	302	160	217	350	13	6	8	8	46	27	39	44
10	1725 m ESE	MM	2	<2	1	2	192	160	150	200	8	4	4	3	19	19	17	12
11	825 m SSE	SM	4	<2	4	4	638	420	717	725	30	17	38	21	118	88	300	115
Control Area ** (>3,000 m W)		SM	<2	<2	<1	<1	153	70	44	88	5	2	1	2	50	33	37	44
		MM	<2	<2	<1	<1	188	115	46	80	10	3	1	2	21	16	11	14
		SUM	-	-	-	<1	-	-	-	92	-	-	-	2	-	-	-	12
Upper Limits of Normal***		Rural	8				500				30				250			
		Urban	8				1000				60				250			
Former Phytotoxicology Excessive Levels		Rural	10				800				50				300			

a MM - Manitoba maple
SM - silver maple
RM - red maple
SUM - sugar maple

b Mean of triplicate sample results

c Mean of duplicate sample results

d Based on a single sample result

* In previous reports, the site distance should have read 450 m rather than 415 m

** Site change in 1981 - In 1980, Site 8 was situated at 1915 m ENE
- In 1981, the control site was changed to a site off Bay Road

*** "Upper Limits of Normal" were established by the Phytotoxicology Section in 1984 and replace the former "Phytotoxicology Excessive Levels".

TABLE 1: ANALYTICAL RESULTS FOR UNWASHED MAPLE FOLIAGE COLLECTED IN THE VICINITY OF IVACO IN AUGUST 1984 COMPARED TO EARLIER YEARS' RESULTS

(Continued)

Site #	Approximate Distance & Direction	Foliage Description	Mean Concentration of Unwashed Maple Foliage - parts per million - dry weight basis										
			Cd			Cu			Ni			Mo^e	V^e
			1980^b	1983^b	1984^c	1980^b	1983^b	1984^c	1980^b	1983^b	1984^c	1984^c	1984^c
4	1350 m WSW	SM	0.4	<0.1	0.2	8	8	7	<1.0	<1	<1	<0.5	<1
2*	450 m NW	SM	0.4	<0.1	<0.1	8	6	7	<1.0	<1	<1	0.6	<1
1	265 m N	RM-1980	0.3	-	-	5	-	-	<1.0	-	-	-	-
		SUM-1984	-	-	0.2	-	-	7	-	-	1	1.5	1
3	900 m N	SM	<0.2	0.3	0.2	7	9	11	2.0	1	<1	0.5	<1
6	675 m ENE	MM	0.4	0.1	0.2	7	8	8	<1.0	1	2	0.9	<1
7	1165 m ENE	MM	<0.2	<0.1	<0.1	6	8	6	<1.0	<1	<1	0.6	<1
8**	1800 m ENE	MM	<0.2	<0.1	<0.1	8	7	8	<1.0	<1	<1	0.6	<1
9	865 m E	MM	<0.2	<0.1	0.2	5	7	7	<1.0	<1	<1	1.0	<1
10	1725 m ESE	MM	<0.2	<0.1	<0.1	6	6	6	<1.0	<1	<1	<0.5	<1
11	825 m SSE	SM	0.5	0.5	0.3	9	11	11	1.8	2	<1	0.7	<1
Control Area** (>3000 m W)		SM	<0.2	0.3	<0.1	8	13	8	1.8	<1	<1	<0.5	<1
		MM	<0.2	<0.1	<0.1	5	5	8	1.5	<1	<1	0.6	<1
		SUM	-	-	<0.1	-	-	5	-	-	<1	0.6	<1
Upper Limits of Normal***		Rural		1			20			5		1.5	5
		Urban		3			20			7		1.5	5
Former Phytotoxicology Excessive Levels		Rural		3			30			15		8.0	10

a MM - Manitoba maple
SM - silver maple
RM - red maple
SUM - sugar maple

b Mean of triplicate sample results

c Mean of duplicate sample results

e Samples prior to 1984 were not analyzed for this element

* In previous reports, the site distance should have read 450 m rather than 415 m

** Site change in 1981 - In 1980, site 8 was situated 1915 m ENE
- In 1981, the control site was changed to a site off Bay Road

*** "Upper Limits of Normal" were established by the Phytotoxicology Section in 1984 and replace the former "Phytotoxicology Excessive Levels".

TABLE 2: ANALYTICAL RESULTS FOR SOIL (0-5 cm) COLLECTED IN THE VICINITY OF IVACO IN AUGUST 1984 COMPARED TO THE CORRESPONDING SEPTEMBER 1980 RESULTS

Site #	Approximate Distance & Direction	[b]Mean Concentration of Surface Soil - parts per million - dry weight basis														
		Cd		Cr		Cu		Pb		Ni		Zn		Fe[c]	Mo[c]	V[c]
		1980	1984	1980	1984	1980	1984	1980	1984	1980	1984	1980	1984	1984	1984	1984
4	1350 m WSW	<0.5	<0.5	16	19	6	6	12	12	8	8	45	49	11,000	<1	19
2	415 m NW	<0.5	-	25	-	13	-	9	-	12	-	51	-	-	-	-
2a*	450 m NW	-	0.5	-	88	-	26	-	23	-	34	-	90	30,500	<1	55
1	265 m N	<0.5	0.5	52	64	42	28	30	32	33	28	106	95	25,500	<1	44
3	900 m N	<0.5	<0.5	45	34	31	13	22	27	35	16	88	83	17,500	<1	32
6	675 m ENE	<0.5	<0.5	25	34	16	15	25	32	14	15	103	80	15,000	<1	28
8	2065 m ENE	<0.5	<0.5	32	37	16	12	16	15	17	16	61	57	18,500	<1	33
9	865 m E	<0.5	<0.5	20	21	12	13	13	25	7	8	38	57	9,150	<1	17
10	1725 m ESE	<0.5	<0.5	24	20	17	15	30	33	12	11	65	62	16,000	<1	27
11	825 m SSE	<0.5	1.0	78	95	53	30	46	64	49	37	160	180	35,000	<1	66
Control Area (>3000 m W)		<0.5	<0.5	66	27	59	11	60	17	65	13	147	66	14,000	<1	24
Upper Limits of Normal**	Rural		3.0		50		60		150		60		500	35,000	2	70
	Urban		4.0		50		100		500		60		500	35,000	3	70
Former Phytotoxicology Excessive Levels-	Rural		5.0		75		100		150		70		300	-	5	150

b Average of triplicate sample results in 1980 and of duplicate results in 1984.

c 1980 samples not analyzed for this element

* New site in 1984

** "Upper Limits of Normal" were established by the Phytotoxicology Section in 1984 and replace the former "Phytotoxicology Excessive Levels."

TABLE 3: SUMMARY OF ANALYTICAL MOSS BAG RESULTS FOR THE SIX EXPOSURE PERIODS FROM OCTOBER 1984 THROUGH APRIL 1985

Site #	Data Summary	Range and Mean of All Chemical Data (ppm)								
		Cd	Cr	Cu	Fe	Pb	Mo	Ni	V	Zn
1	Range	0.4-3.3	3-14	6-23	960-4,000	27-180	0.5-5.0	2-5	3-6	38-1,300
	Mean	1.1	8	12	2,026	60	1.9	3	4	321
	Exc.*	1	3	4	2	3	a	0	a	5
2	Range	0.3-1.0	4-10	12-19	1,100-2,400	22-64	<0.5-1.5	2-4	3-5	66-350
	Mean	0.7	7	15	1,600	43	0.9	3	4	223
	Exc.*	0	1	5	1	4	a	0	a	4
3	Range	1.2-3.0	6-18	9-20	1,600-4,400	64-190	0.9-1.9	2-5	3-6	310-810
	Mean	2.0	14	17	3,350	105	1.5	3	5	510
	Exc.*	2	5	6	5	6	a	0	a	6
4	Range	0.3-0.5	2-3	4-8	850-1,100	14-28	<0.5-0.6	1-2	3	30-48
	Mean	0.3	3	6	977	21	0.5	2	3	41
	Exc.*	0	0	0	0	0	a	0	a	0
5	Range	0.3-0.6	3-4	6-14	1,000-1,300	24-65	<0.5-0.8	2-3	3-6	42-120
	Mean	0.5	4	9	1,150	42	0.3	2	4	68
	Exc.*	0	0	2	0	4	a	0	a	1
6	Range	0.3-0.5	2-3	6-9	800-1,000	29-51	<0.5-0.7	2-3	3-4	29-48
	Mean	0.4	2	8	925	36	0.5	2	3	40
	Exc.*	0	0	1	0	2	a	0	a	0
ULN	Rural	2	a	8	1,700	35	a	6	a	100
	Urban	4	7	60	3,000	200	a	13	a	800

* Number of occasions the rural guideline was exceeded

a. No guideline established

ULN - Upper Limit of Normal

TABLE 4: MOSS SITES WHERE METAL CONCENTRATIONS IN EXCESS OF THE RESPECTIVE RURAL GUIDELINES WERE DOCUMENTED AT THE END OF EACH 30 DAY EXPOSURE PERIOD

Exposure Period	Sites Where Exceedances Were Found					
	Cd	Cr	Cu	Fe	Pb	Zn
Oct-Nov	1,3	1*,2*,3*	1,2,3,5,6	1*,2,3	1,2,3,5	1*,2,3*,5
Nov-Dec	-	3*	1,2,3,5	3*	1,2,3,5,6	1,2,3
Dec-Jan	-	-	2,3	-	3,5	3
Jan-Feb	3	1*,3*	1,2,3	3*	1,2,3,5,6	1,2,3
Feb-Mar	-	3*	2,3	3*	2,3	1,2,3
Mar-Apr	-	1*,3*	1,3	1,3*	3	1,3
Upper Limits of Normal						
Rural	2	a	8	1,700	35	100
Urban	4	7	60	3,000	200	800

a No rural guideline established

* The concentration exceeds urban guideline

TABLE 5: AVERAGE[a] METAL CONCENTRATION IN THE PARTICULATE MATERIAL FILTERED FROM THE SNOW COLLECTED AT EACH SITE REPRESENTING APPROXIMATELY A THREE-MONTH PERIOD FROM DECEMBER 1985 THROUGH FEBRUARY 28, 1985

Site # (See Figure 2)	*Concentration - ug/g of Particulate Material						
	Pb	Cd	Zn	Cu	Ni	Fe	Cr
Sites Closest to IVACO							
1	1,954	28	7,185	465	187	175,348	1,117
2	967	30	3,074	539	144	136,832	714
Remote Sites							
3	260	5	682	112	64	34,707	128
4	184	4	36	184	184	14,703	147

a Mean of duplicate sample results

* Concentration (ug/g) in particulate material alone =
= (Conc of metal in total sample (ug/g) x weight of total sample (g))
- (Conc of metal in blank filter x weight of blank filter paper)
÷ (Total weight of sample - weight of blank filter)

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